

PATENT COOPERATION TREATY

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From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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PCT

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing  
(day/month/year)

29.11.2004

Applicant's or agent's file reference  
RSNP13097PC

IMPORTANT NOTIFICATION

International application No.  
PCT/GB 03/04094

International filing date (day/month/year)  
25.09.2003

Priority date (day/month/year)  
26.09.2002

Applicant  
DORLING, Kevin

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international  
preliminary examining authority:



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# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Article 36 and Rule 70)

|  |   |   |
|--|---|---|
| Applicant's or agent's file reference<br><b>RSNP13097PC</b>  | <b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)  |   |
| International application No.<br><b>PCT/GB 03/04094</b>  | International filing date (day/month/year)<br><b>25.09.2003</b>   | Priority date (day/month/year)<br><b>26.09.2002</b> |
| International Patent Classification (IPC) or both national classification and IPC<br><b>F01D5/18</b>   |   |   |
| Applicant<br><b>DORLING, Kevin</b>   |   |   |
| <p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 10 sheets.</p>  |   |   |
| <p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li>I <input checked="" type="checkbox"/> Basis of the opinion</li> <li>II <input type="checkbox"/> Priority</li> <li>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li>IV <input type="checkbox"/> Lack of unity of invention</li> <li>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li>VI <input type="checkbox"/> Certain documents cited</li> <li>VII <input type="checkbox"/> Certain defects in the international application</li> <li>VIII <input type="checkbox"/> Certain observations on the international application</li> </ul> |   |   |
| Date of submission of the demand<br><br><b>02.04.2004</b>  | Date of completion of this report<br><br><b>29.11.2004</b>  |   |
| Name and mailing address of the international preliminary examining authority:<br><br> <b>European Patent Office - P.B. 5818 Patentlaan 2<br/>NL-2280 HV Rijswijk - Pays Bas<br/>Tel. +31 70 340 - 2040 Tx: 31 651 epo nl<br/>Fax: +31 70 340 - 3016</b>  | Authorized Officer<br><br><b>O'Shea, G</b><br><br>Telephone No. +31 70 340-4424  |   |

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB 03/04094

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

1-13 as originally filed

**Claims, Numbers**

1-55 filed with telefax on 02.11.2004

**Drawings, Sheets**

1/3, 3/3 as originally filed

2/3 filed with telefax on 02.06.2004

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☒ the claims, Nos.: 56,57  
☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB 03/04094

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

|                               |             |      |
|-------------------------------|-------------|------|
| Novelty (N)                   | Yes: Claims | 1-55 |
|                               | No: Claims  |      |
| Inventive step (IS)           | Yes: Claims | 1-55 |
|                               | No: Claims  |      |
| Industrial applicability (IA) | Yes: Claims | 1-55 |
|                               | No: Claims  |      |

**2. Citations and explanations**

**see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following documents:

D1: EP-A-0 939 196 (TOKYO SHIBAURA ELECTRIC CO) 1 September 1999

D2: EP-A-0 852 285 (GEN ELECTRIC) 8 July 1998

- 2.1 The document D2 is regarded as being the closest prior art to the subject-matter of claim 1, and shows:

A turbine blade having at least one internal cooling passage which has a plurality of turbulence promoting ribs comprising two rib portions arranged in chevron formation, the included angle of each chevron being between 80 and 120 degrees. There is a gap at the apex of each chevron between each rib portion.

The subject-matter of claim 1 differs from this known turbine blade in that there is at least one gap provided in each of the rib portions.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as providing a turbine blade having improved cooling.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The provision of gaps in both rib portions of the turbulator (as opposed to having one gap at the apex of the chevron) further increases the turbulence in the flow of the cooling medium, thereby improving the heat transfer between the cooling fluid and the blade. Such a configuration is neither disclosed nor immediately derivable from the prior art.

As claims 49 and 50 contain all the features of claim 1, they also meet the requirements of the PCT with respect to novelty and inventive step.

- 2.2 With regard to the subject matter of independent claim 51, the closest prior art is

document D1 and it shows:

A turbine blade having at least one internal cooling passage which has a plurality of turbulence promoting ribs wherein at least one of the ribs has a trapezoidal cross-sectional shape and extends into the flow.

The subject-matter of claim 51 differs from this known turbine blade in that the at least one rib extends from the channel wall surface at an angle greater than 60 and less than 90 degrees such that the rib is directed into the direction of the flow of the cooling medium.

The subject-matter of claim 51 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as providing a turbine blade having improved cooling.

The solution to this problem proposed in claim 51 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The angular orientation of the blades and their cross sectional shape is such as to further increase the turbulence in the flow of the cooling medium, thereby increasing the heat transfer between the cooling medium and the turbine blade. The teachings of D1 are to prevent generation of swirl of the cooling flow by means of an angular dimensional range falling outside the range of that of claim 51. As the current application seeks to solve a different problem, ie. to promote turbulence, it is not merely a matter of normal design procedure to carry out the invention with the claimed angles as there are no teachings in the prior art to do so.

- 2.3 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 54, which therefore is also considered new and inventive.
- 2.4 Claims 2-50, 52-53 and 55 are dependent on claims 1, 51 and 54 respectively and, as such, also meet the requirements of the PCT with respect to novelty and inventive step.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB 03/04094

- 3.3 Claims 1-55 are deemed to be industrially applicable (Article 33(4) PCT).
4. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 and D2 is not mentioned in the description, nor are these documents identified therein.

**10/528896****JC14 Rec'd PCT/PTO 23 MAR 2005**

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CLAIMS

1. A turbine blade having opposing pressure and suction side walls adjoining at leading and trailing edges of the blade, and defining at least one internal channel providing a flow passage for a cooling medium, said at least one channel including a plurality of turbulence promoting ribs mounted on a channel wall surface, wherein each rib comprises two rib portions joined at one end thereof to form a chevron junction, said chevron junction defining an angle of between 80° and 120° between the two rib portions and being directed into the flow of the cooling medium within the at least one channel, and wherein at least one gap is provided in one rib portion, and at least one gap is provided in the other rib portion.
2. A turbine blade as claimed in claim 1, wherein one rib portion is disposed at an angle of 120° from the other rib portion.
3. A turbine blade as claimed in claim 1 or 2, wherein the at least one channel has a substantially triangular cross-section.
4. A turbine blade as claimed in claim 1 or 2, wherein the at least one channel has a substantially circular cross-sectional shape.
5. A turbine blade as claimed in any preceding claim, wherein adjacent ribs are aligned such that adjacent chevron junctions are longitudinally aligned with respect to the at least one channel.



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6. A turbine blade as claimed in any one of claims 1 to 4, wherein adjacent ribs are misaligned such that adjacent chevron junctions are longitudinally offset.

5

7. A turbine blade as claimed in any preceding claim, wherein the ribs are mounted on opposing sides of the at least one channel.

10

8. A turbine blade as claimed in claim 7, wherein each opposing rib is laterally aligned with respect to the at least one channel.

15

9. A turbine blade as claimed in claim 7, wherein each opposing rib is laterally offset with respect to the at least one channel.

20

10. A turbine blade as claimed in any preceding claim, wherein the gaps of each adjacent rib are longitudinally aligned with respect to the at least one channel.

25

11. A turbine blade as claimed in any one of claims 1 to 9, wherein the gaps in each adjacent rib are longitudinally offset with respect to the at least one channel.

30

12. A turbine blade as claimed in any preceding claim, wherein the centre of the at least one gap is located between 60% and 70% along the length of a respective rib portion from the chevron junction.

13. A turbine blade as claimed in any preceding claim, wherein the centre of the at least one gap is located

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around two thirds along the length of a respective rib portion from the chevron junction.

5 14. A turbine blade as claimed in any preceding claim, wherein at least one of the ribs extends substantially perpendicular from the surface of the at least one channel.

10 15. A turbine blade as claimed in an preceding claim, wherein at least one of the ribs extends from the surface of the at least one channel at an angle of between 45° to 135° with respect to the direction of flow through the at least one channel.

15 16. A turbine blade as claimed in any preceding claim, wherein at least one of the ribs extends at an angle of between 60° to 90° from the surface of the at least one channel with respect to the direction of flow therethrough.

20 17. A turbine blade as claimed in any preceding claim, wherein at least one of the ribs extends at an angle of between 62° to 79° from the surface of the at least one channel with respect to the direction of flow  
25 therethrough.

18. A turbine blade as claimed in any preceding claim, wherein the ribs have a trapezoidal cross-section.

30 19. A turbine blade as claimed in any preceding claim, wherein the ribs have a cross-section in the form of a parallelogram.

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20. A turbine blade as claimed in any preceding claim,  
wherein the ribs have a square cross-section.

5 21. A turbine blade as claimed in any preceding claim,  
wherein adjacent ribs are spaced apart by between 4 and 6  
mm.

10 22. A turbine blade as claimed in any preceding claim,  
wherein adjacent ribs are spaced apart by between 4 and 5  
mm.

15 23. A turbine blade as claimed in any preceding claim,  
wherein adjacent ribs are spaced apart by 4.4 mm.

24. A turbine blade as claimed in any preceding claim,  
wherein the ribs have a height of between 0.45 and 0.75  
mm.

20 25. A turbine blade as claimed in any preceding claim,  
wherein the ribs have a height of between 0.5 and 0.6 mm.

25 26. A turbine blade as claimed in any preceding claim,  
wherein the ribs have a height of 0.52 mm.

27. A turbine blade as claimed in any preceding claim,  
wherein the ribs have a width of between 0.45 and 0.75  
mm.

30 28. A turbine blade as claimed in any preceding claim,  
wherein the ribs have a width of 0.6 mm.

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29. A turbine blade as claimed in any preceding claim, wherein the gaps in the ribs are between 0.45 and 0.75 mm wide.

5 30. A turbine blade as claimed in any preceding claim, wherein the gaps in the ribs are 0.54 mm wide.

10 31. A turbine blade as claimed in any preceding claim, wherein the at least one channel is located in the region of the leading edge of the blade.

15 32. A turbine blade as claimed in any preceding claim, wherein the at least one channel is defined by the pressure wall, the suction wall and a web portion extending between the pressure and suction walls.

20 33. A turbine blade as claimed in any preceding claim, wherein the ribs are located in at least one channel in the region of the leading edge of the blade, such that one rib portion is located on the pressure wall, and the other rib portion is located on the suction wall, and the chevron junction is aligned with the leading edge.

25 34. A turbine blade as claimed in any one of claims 1 to 30, wherein the at least one channel is located in a mid-passage of the blade, between the leading and trailing edges of the blade.

30 35. A turbine blade as claimed in any preceding claims, wherein the blade includes a plurality of internal channels.

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36. A turbine blade as claimed in claim 35, wherein at least one of the plurality of channels is located in the region of the leading edge of the blade, and at least one channel is located in a mid-passage of the blade, between the leading and trailing edges.

37. A turbine blade as claimed in any preceding claim, wherein the at least one channel is of a single pass form.

38. A turbine blade as claimed in any one of claims 1 to 36, wherein the at least one channel is of a serpentine form.

39. A turbine blade as claimed in any preceding claim, wherein the turbine blade further includes a root portion and a tip portion, wherein the pressure and suction walls and the leading and trailing edges extend from the root portion to the tip portion of the blade.

40. A turbine blade as claimed in claim 39, wherein the cooling medium is supplied to the blade via the root portion.

41. A turbine blade as claimed in claim 39 or 40, wherein the root portion is of a fir-tree type.

42. A turbine blade as claimed in claim 39 or 40, wherein the root portion is of a dove tail type.

43. A turbine blade as claimed in any preceding claim, wherein the external surface of the turbine blade defines a plurality of apertures providing fluid communication

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between the at least one cooling channel and the exterior of the blade.

5 44. A turbine blade as claimed in any preceding claim, wherein the cooling medium is air.

45. A turbine blade as claimed in any preceding claim, wherein the cooling medium is compressed air fed from a compressor.

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46. A turbine blade as claimed in any preceding claim, wherein the turbine blade is a rotor blade of a gas turbine engine.

15 47. A turbine blade as claimed in any preceding claim, wherein the blade is a first stage rotor blade of a gas turbine engine.

20 48. A turbine blade as claimed in any one of claims 1 to 45, wherein the turbine blade is a stator blade of a gas turbine engine.

25 49. A gas turbine engine including a plurality of turbine blades, at least one turbine blade having opposing pressure and suction side walls adjoining at leading and trailing edges of the blade, and defining at least one internal channel providing a flow passage for a cooling medium, said at least one channel including a plurality of turbulence promoting ribs mounted on a channel wall surface, wherein each rib comprises two rib portions joined at one end thereof to form a chevron junction, said chevron junction defining an angle of between 80° and 120° between the two rib portions and

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being directed into the flow of the cooling medium within the at least one channel, and wherein at least one gap is provided in one rib portion, and at least one gap is provided in the other rib portion.

5

50. Electrical generating means including a gas turbine engine, said gas turbine engine including a plurality of turbine blades, at least one turbine blade having opposing pressure and suction side walls adjoining at leading and trailing edges of the blade, and defining at least one internal channel providing a flow passage for a cooling medium, said at least one channel including a plurality of turbulence promoting ribs mounted on a channel wall surface, wherein each rib comprises two rib portions joined at one end thereof to form a chevron junction, said chevron junction defining an angle of between  $80^\circ$  and  $120^\circ$  between the two rib portions and being directed into the flow of the cooling medium within the at least one channel, and wherein at least one gap is provided in one rib portion, and at least one gap is provided in the other rib portion.

51. A turbine blade having opposing pressure and suction side walls adjoining at leading and trailing edges of the blade, and defining at least one internal channel providing a flow passage for a cooling medium, said at least one channel including a plurality of turbulence promoting ribs mounted on a channel wall surface, wherein at least one rib has a trapezoidal cross-sectional shape and extends from the channel wall surface at an angle greater than  $60^\circ$  and less than  $90^\circ$ , such that said at least one rib is directed into the direction of flow of the cooling medium within the at least one channel.

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52. A turbine blade as defined in claim 51, wherein the at least one rib extends from the channel wall surface at an angle of between  $62^{\circ}$  and  $79^{\circ}$ .

5

53. A turbine blade as defined in claim 51 or 52, wherein the cross-sectional shape of the at least one rib is defined by a base and a tip joined by two flanks aligned parallel to each other.

10

54. A turbine blade having opposing pressure and suction side walls adjoining at leading and trailing edges of the blade, and defining at least one internal channel providing a flow passage for a cooling medium, said at least one channel including a plurality of turbulence promoting ribs mounted on a channel wall surface, wherein at least one rib has a cross-sectional shape in the form of a parallelogram and extends from the channel wall surface at an angle greater than  $60^{\circ}$  and less than  $90^{\circ}$ , such that said at least one rib is directed into the direction of flow of the cooling medium within the at least one channel.

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55. A turbine blade as defined in claim 54, wherein the at least one rib extends from the channel wall surface at an angle of between  $62^{\circ}$  and  $79^{\circ}$ .

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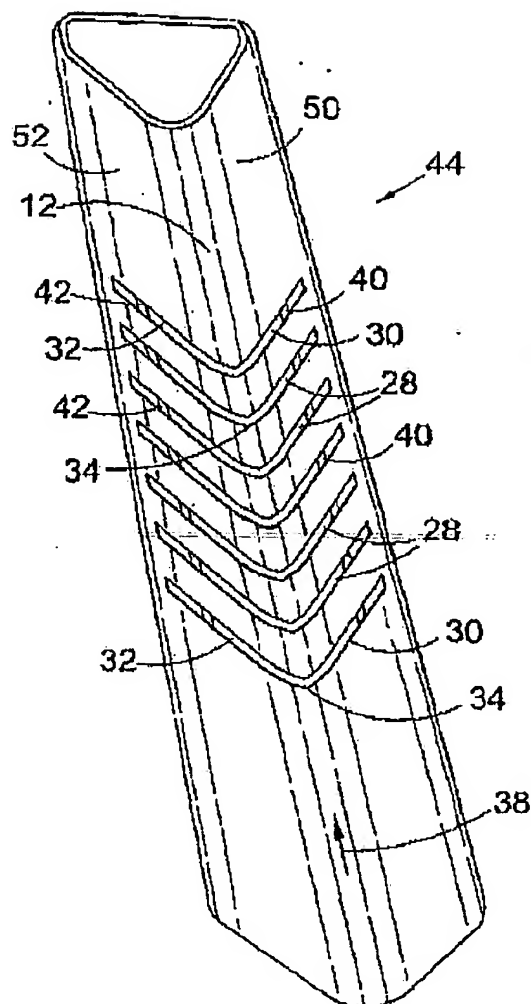


Fig. 3